15. (Amended) The hydrogen purifying apparatus in accordance with claim 13, wherein said reaction segment has at least a two-segmented catalyst layer, and at least the uppermost catalyst layer is composed of catalyst pellets and the lowermost catalyst layer has a shape of a honeycomb.

16. (Amended) The hydrogen purifying apparatus in accordance with claim 13, wherein said reaction segment comprises an uppermost honeycomb shaped catalyst layer and a lowermost honeycomb shaped catalyst layer, where the uppermost catalyst layer is larger than the lowermost catalyst layer with respect to an open area at the honeycomb lattice.

REMARKS

Claims 1-19 are presently pending.

The specification has been amended to add a description in the section "BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING" to include the cross-referencing of different reference numerals in the drawings. The specification has also been amended to add reference numerals that correspond to the drawings, and correct incorrect references.

A marked-up version of the amended portions of the specification, showing the changes made, is provided on separate pages attached hereto as "Marked-Up Version of Specification" in accordance with 37 C.F.R. § 1.121.

The Examiner has objected to the drawings because they include reference numerals not mentioned in the description. Accompanying this Response are proposed changes to the drawings shown in red ink, deleting numerals in Figures 5 and 7 not referenced in the specification. These features of the drawings were not considered important enough to describe in the specification.

In addition, Applicants have amended the specification to insert reference numerals 12, 22, and 121b. Support for the insertion of these reference numerals is in Figures 3, 4, and 12. The specification has also been amended to cross-relate reference numerals contained in Figures 3-5, and 7 with reference numerals 3-10, shown in Figure 1, and described in the specification on pages 13-14. In Figures 9 and 11-13, reference numerals 102, 106 and 107 designate the identically numbered elements shown in Figure 8 and described in page 31 of the

specification. In light of these amendments, the applicants have fully complied with 37 C.F.R. 1.84(p)(5). It is requested that the amendments to the drawings be entered and that the Examiner's objection be reconsidered and withdrawn.

The Examiner has objected to claim 15 as being informal. Applicants have corrected the informality, and respectfully request reconsideration and withdrawal of the objection.

The Examiner has rejected claims 3-4, 7-11 and 12-19 under 35 U.S.C. §112, second paragraph, as being indefinite. While not agreeing that these claims are indefinite, Applicants have amended claim 3 to recite that the up and downstream sides of the catalyst layer are formed of different catalyst materials.

In claim 7, Applicants have removed the term "close" and substituted "adjacent to." In claim 8, Applicants have amended the claim to recite that the reformed gas flows in a first direction prior to passing through the cooling means, and passes through the catalyst layer in a second direction, and that the first and second directions are opposing.

Applicants have amended claim 12 to recite that a branched pathway is formed which includes a catalyst layer heating branch and a catalyst layer cooling branch, the catalyst layer heating branch being connected to the reaction segment at the middle point of the catalyst layer, and the catalyst layer cooling branch being connected to the reaction segment at an upstream point of the catalyst layer. Applicants have also amended claim 16 to recite that the reaction segment includes an uppermost honeycomb shaped catalyst layer and a lowermost honeycomb shaped catalyst layer, where the uppermost catalyst layer is larger than the lowermost side catalyst layer with respect to an open area at the honeycomb lattice.

In light of the foregoing amendments, the claims are in compliance with 35 U.S.C. § 112, second paragraph. Reconsideration and withdrawal of the rejections are requested.

The Examiner has rejected claims 1-2 and 5-6 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 5,874,051 of Heil et al. ("Heil"). The Examiner contends that Heil discloses a hydrogen purifying apparatus including a reaction segment, a reformed gas supply segment, an oxidant gas supplying segment, means for cooling the catalyst on the upstream layer and means for heating the catalyst layer on the downstream side. The Examiner contends that the heating means is the exothermic carbon monoxide oxidation reaction that is

controlled by the apparatus. This rejection is respectfully traversed for the reasons set forth below.

The presently claimed invention includes means for heating the catalyst layer at a downstream side. The Examiner argues that the exothermic reaction in Heil that is controlled along the reactor path is the heating means of the presently claimed invention. Applicants disagree. In Heil, the means for heating the catalyst layer is the oxidizing gas that is metered through devices 4, where the controlled addition of the oxidizing gas influences the exothermal oxidation reaction (col. 4, lines 36-40, and claim 1). First, the introduction of an oxidizing gas as in Heil to further an exothermic action is fundamentally different from the indirect transfer of heat through the walls of a heater or a heating fin as in the presently claimed invention. However, in addition, while the exothermic reactions in Heil that produce heat occur in the catalyst support units 5, the means for heating is the controlled addition of the oxidizing gas upstream of the catalyst support units 5 where the exothermic reactions take place (Figure 1). Heil's heating means therefore does not meet the feature of the presently claimed invention where the means for heating the catalyst layer is at the downstream side of the catalyst layer. In addition, with respect to claim 2, the presently claimed invention recites that the heating means at the downstream side is a heater, e.g., heater 61 in Figure 7. In Heil, not only is no heater disclosed, but the specification indicates that no additional complex heating circuit is required (col. 2, lines 30-31).

Therefore, Applicants submit that the cited art fails to disclose the features of the present invention. Reconsideration and withdrawal of the rejection are respectfully requested.

The Examiner has rejected claims 3 and 4 under 35 U.S.C. § 103(a) as being unpatentable over Heil, in view of U.S. Patent No. 5,330,727 of Trocciola et al. ("Trocciola"). The Examiner acknowledges that Heil fails to include catalyst layers formed of different catalyst materials, but concludes that it would have been obvious to combine the operation of the two different catalyst beds as in Trocciola with Heil. This rejection is respectfully traversed for the reasons set forth below.

As discussed above, Heil does not disclose a heating means as in the presently claimed invention for heating the catalyst layer at the downstream side. Trocciola does not remedy this deficiency. Trocciola relates to an apparatus for removing carbon monoxide from gaseous media using two stages. Heat exchange coils 24 and 34 reside in stages 20 and 30

respectively, and a heat exchanger 40 is located between the stages, but all three of these devices are for cooling, not for heating the catalyst layer at the downstream side. Additionally, although Trocciolla describes two separate catalyst beds operating at different temperatures, Trocciola does not describe the catalyst in the upstream layer being formed of different materials from the catalyst in the downstream layer, where the downstream side catalyst exerts activity at a lower temperature than the catalyst in the upstream side, as in claim 3 of the presently claimed invention.

Therefore, the cited references, whether taken alone or in combination, fail to teach or suggest the elements of the presently claimed invention, or make out a prima facie case of obviousness. However, even if a prima facie case of obviousness had been made out, the presently claimed invention possesses unexpected advantages characteristic of the invention. By heating the downstream side of the catalyst it is not necessary to heat the catalyst upstream side, which can potentially result in rapid temperature increases, since the catalyst reaction starts after the catalyst temperature exceeds the reaction temperature. In the presently claimed invention, by heating the downstream side of the catalyst, the rapid increase in the catalyst temperature in the upstream side can be prevented. In addition, using a downstream catalyst layer operable at low temperatures, and heating means on the downstream side provides advantages in that less time is required for heating the downstream catalyst layer to the required reaction temperatures. By avoiding temperature excursions in the upstream layer, time is also saved by not having to re-cool the upstream layer back down to a proper operating temperature. Reconsideration and withdrawal of the rejections are therefore respectfully requested.

The Examiner has rejected claims 7-11 under 35 U.S.C. § 103(a) as being unpatentable over Heil in view of U.S. Patent No. 3,910,770 of Kobylinski et al. ("Kobylinski"). The Examiner acknowledges that Heil fails to disclose a flow pathway of the reformed gas formed close to the catalyst layer via a partition so as to heat the catalyst, but nevertheless concludes that it would have been obvious to combine the catalyst heating structure of Kobylinski with the apparatus of Heil. This rejection is traversed for the reasons discussed below.

As discussed above, Heil does not disclose a heating means as in the presently claimed invention for heating the catalyst layer at the downstream side. Kobylinski does not remedy this deficiency. Kobylinski teaches a two-stage converter for reducing nitrogen oxides

and oxidizing carbon monoxide and unburned hydrocarbons (col. 2, lines 45-48), but Kobylinski does not include a heating means as in the presently claimed invention for heating the catalyst layer at the downstream side. Kobylinski also does not contain a cooling means. A cooling means is not necessary in Kobylinski since the reactions in Kobylinski are favored by higher temperatures. In contrast, the selective carbon monoxide oxidation reactions of the presently claimed invention require a cooling means since a reaction between carbon dioxide and hydrogen to form carbon monoxide, occurs at high temperatures.

In addition, as recited in claim 7 of the presently claimed invention, the flow pathway of the hydrogen purifying apparatus is such that the reformed gas heats the down stream side of the catalyst layer before passage through the cooling means. However, in Heil the gas entering the reaction chamber 2 is cooled by cooling chamber 6 prior to any heating. Also, claim 7 describes heating the down stream side of the catalyst layer, whereas in both Heil and Kobylinski, the length of the catalyst chamber is heated

The combination of the cited art does not therefore describe all the elements of the presently claimed invention.

Further, the combination of Kobylinski with Heil would change the principle of operation of Heil, since Heil performs a selective catalytic carbon monoxide oxidation (col. 7, lines 4-6), and can be used for feeding a fuel cell at about 80° C (col. 6, line 63 to col. 7, line 4). Kobylinski describes a high-temperature process with complete oxidation (col. 4, lines 50-58) and catalyst bed temperatures of 1400° F (760° C) (col. 4, lines 51-58). Finally, there would be no motivation to combine Kobylinski with Heil since Heil utilizes cooling means and Kobylinski does not.

Heil and Kobylinski are therefore not properly combinable, but even if combined do not disclose all the features of the presently claimed invention. Reconsideration and withdrawal of the rejection are respectfully requested.

The Examiner has rejected claims 12-19 as being unpatentable over Heil. This rejection is respectfully traversed for the reasons set forth below.

First, as discussed above, Heil does not disclose a heating means as in the presently claimed invention for heating the catalyst layer at the downstream side. Further, the Examiner acknowledges that Heil fails to disclose introducing a mixture of reformed gas and oxidant gas at a middle point of the catalyst layer, but concludes that it would have been obvious

to introduce the mixture of oxidant and reformed gas at a middle point of the catalyst layer in order to further enable controlling the exothermal CO oxidation along the reactor path. This reasoning is not correct, because oxidizing gas introduced at the middle point of the catalyst arrangement in Heil would have the opposite effect, since the gas would not then have the opportunity to be processed by mixing structure 8, specifically provided to prevent localized high concentrations of the oxidizing gas (col. 4, lines 13-16). These mixing structures are present to permit cooling the mixed gas stream before it reaches the catalyst (col. 4, lines 31-34). Modifying Heil in the suggested manner would thus teach away from the invention.

Therefore, the cited art does not teach or suggest the elements of the presently claimed invention. Reconsideration and withdrawal of the rejection are respectfully requested.

CONCLUSION

In view of the foregoing amendment and remarks, Applicants respectfully submit that the present application, including claims 1-19 are in condition for allowance, and request an early notice thereof.

Respectfully submitted,
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(Date)

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MARKED-UP VERSION OF CLAIMS

1. (Amended) A hydrogen purifying apparatus for oxidizing and removing carbon monoxide in a reformed gas containing carbon monoxide in addition to a main component of hydrogen gas, comprising a reaction segment having a catalyst layer for oxidizing carbon monoxide, a reformed gas supplying segment for supplying said reformed gas to said reaction segment via a reformed gas supply pathway, an oxidant gas supplying segment for supplying an oxidant gas on the path of said reformed gas supply pathway, means for cooling said catalyst layer at [the] an upstream side, and means for heating said catalyst layer at [the] a downstream side.

3. (Amended) The hydrogen purifying apparatus in accordance with claim 2, wherein said upstream side of said catalyst layer is formed [by a] of different catalyst materials than [from] that of said downstream side, and the catalyst constituting said downstream side exerts the activity at lower temperature than the catalyst constituting said upstream side.

7. (Amended) The hydrogen purifying apparatus in accordance with claim 2, wherein a flow pathway of said reformed gas is formed at a position [close to or in close contact with] adjacent to said catalyst layer via a partition so as to heat said down stream side of said catalyst layer by a contact with said reformed gas before the passage through said cooling means.

8. (Amended) The hydrogen purifying apparatus in accordance with claim 7, wherein said reformed gas flows in a first direction prior to passing through said cooling means, and passes through said catalyst layer in a second direction, wherein the first direction and second direction are opposing[an opposing direction of stream to that before the same passes through said cooling means].

12. (Amended) The hydrogen purifying apparatus in accordance with claim 1, wherein a branched pathway is formed which bifurcates downstream from a connection between said reformed gas supply pathway and said oxidant gas supply pathway[and is], thereby forming a catalyst layer heating branch and a catalyst layer cooling branch, the catalyst layer heating branch being connected to said reaction segment at the middle point of said catalyst layer, [said branched pathway acting as said means for cooling the upstream side of said catalyst layer or otherwise said means for heating the downstream side of said catalyst layer]the catalyst layer

cooling branch being connected to said reaction segment at an upstream point of the catalyst layer.

15. (Amended) The hydrogen purifying apparatus in accordance with claim 13, wherein said reaction segment has at least a two-segmented catalyst layer, and at least the uppermost catalyst layer is composed of [a] catalyst [pellet] pellets and the lowermost catalyst layer has a shape of a honeycomb.

16. (Amended) The hydrogen purifying apparatus in accordance with claim 13, wherein said reaction segment [has at least a two-segmented] comprises an uppermost honeycomb shaped catalyst layer and a lowermost honeycomb shaped catalyst layer, where[, and] the uppermost catalyst layer is larger than the lowermost [side] catalyst layer with respect to an open area at the honeycomb lattice.

Marked-Up Version of Specification

Paragraph beginning at last line on page 17, and ending at line 22 on page18

FIG. 3 is a schematic cross-sectional view illustrating the hydrogen purifying apparatus in Embodiment 1-2. A provision of the heat exchange fin 20 close to the side wall 12 around the downstream side of the catalyst layer 11 helps to heat the downstream side of the catalyst layer 11. Such structure also facilitates cooling the reformed gas by a heat exchanger 17. Moreover, since the reformed gas flow pathway thermally insulates the catalyst layer 11, the temperature distribution in the center and the periphery of the catalyst layer 11 becomes homogeneous, thereby enabling efficient oxidation of CO. Due to the structure of the apparatus such that the reformed gas passes through the catalyst layer 11 in an opposing direction of stream to that before passing through the heat exchanger 17, the reformed gas at elevated temperature can exchange heat with the downstream side of the catalyst layer 11 and is cooled. Because the reformed gas thus cooled then passes along the upstream side of the catalyst layer 11, the temperature of the catalyst layer 11 can be lowered at the upstream side and elevated at the downstream side. As a result, the temperature distribution can be optimized in response to selective oxidation of CO by the catalyst.

Paragraph on page 19, beginning at line 2 and ending at line 16

The hydrogen purifying apparatus of Embodiment 1-3 in accordance with the present invention will be described herein. As shown in FIG. 4, the hydrogen purifying apparatus in accordance with the present embodiment comprises a reaction chamber 28 formed on the periphery of a tube-shaped reformed gas flow pathway 22, a honeycomb catalyst layer 21 formed inside the reaction chamber 28, and a heat exchange fin 30 provided on a wall of the reformed gas flow pathway neighboring the downstream side of the catalyst layer 21. The operation and effect of the apparatus of this embodiment are mostly similar to those of the apparatus of Embodiment 1-2. Therefore, the description of this embodiment will be focused on different features from those of Embodiment 1-2.

Paragraph beginning at line 26 page 40, and ending at line 9, page 41.

The catalyst reaction segment 118 accommodates therein a first catalyst layer 118a and a second catalyst layer 118b upstream from the catalyst reaction segment 118 to downward in this order. The catalyst reaction segment 118 also accommodates a temperature measuring segment 121a for measuring and indicating the temperature of the first catalyst layer 118a and a temperature measuring segment [120b] 121b for measuring and indicating the temperature of the second catalyst layer 118b. For the first catalyst layer 118a, a catalyst layer with a less number of honeycomb lattices per unit area than that of the second catalyst layer 118b is used. The remaining parts are arranged in the same manner as in Embodiment 2-3.